Appendix I

GEOLOGIC INFORMATION

AT&T Asia-America Gateway
Project (AAG)

BURIAL ASSESSMENT

California Continental Shelf

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BURIAL ASSESSMENT SURVEY (BAS)

1.1 Introduction

This report details the methods of data interpretation and data presentation for the Burial Assessment Survey (BAS), undertaken as part of the survey scope of work. In preparing the BAS, the following were assumed:

ASN were responsible for the cable engineering. This included cable routing, cable armouring and depth of burial. For the Californian Continental Shelf in approaches to the San Luis Obispo landfall, a target burial depth of 1m below the seabed was designated for water depths of less than 1,000 fathoms (1,830m).

The method of installation will be provided by ASN.

1.2 Basis of Interpretation

Fundamentally, the requirements from a BAS, which include trenchability, tow tensions, plough wear, plough speed and plough risk assessment are directly related to 3 factors:

Factor 1 The sediment type and nature of the seabed, i.e. the seabed depth, shape and slope.

Factor 2 The method of installation, ploughing (type of plough), jetting or trenching.

Factor 3 External factors such as intensity of fishing, shipping, dredging and other marine activities.

1.3 Trenchability

The route was classified in to five trenchability classes as detailed in Table 1 below.

Table 1: Trenchability Classes

Trenchability Class	Description
A	Thick very soft to firm clays and up to medium dense sand/silt. Full burial expected to at least 0.8m. Constant burial conditions with low variability. Tow tensions generally low and consistent - <15T. Generally flat seabed (no sedimentary bedforms/low slopes). Low plough pitch/roll expected. Clays - shear strength >4kPa (no plough sinkage expected). Optimal plough progress rate. Low plough share tip wear rate. Seabed also fully jettable.

B	Stiff to very stiff clay and up to dense sand/silt, also anywhere where loose/soft sediment sits over a dense to very dense unit. Reduced and variable burial conditions, but burial not expected to be <0.4m. Tow tensions up to, but not exceeding, 25T. Some plough pitch and roll expected. Minor sedimentary features, but slopes must be <10degrees. Reduced plough progress rate possible. Medium plough share tip wear rate. Reduced jettability and/or multiple passes expected.
C	Stiff to very stiff clay and up to very dense sand/silt, also anywhere where a thin unit of loose/soft sediment sits over a dense to very dense unit, or rock. Poor / variable burial expected - generally <0.4m. Possible spot plough rideouts. Possibility for areas of cable very close to the seabed. Tow tensions may exceed 30T, with high variability and possible renders. Seabed topography may be present, but slopes <10 degrees. High plough pitch/roll events possible. Slow plough progress rate. High plough share tip wear rate. Poor jettability.
D	Not ploughable, due to seabed conditions. Rock outcrop/boulders/seabed debris/slopes >10 degrees Possibly jettable - maybe in short areas between outcrops, on slopes up to 30 degrees, between boulders/debris.
E	Over burial expected with a standard, unmodified plough, due to low seabed bearing capacity. Shear strength <4kPa in upper 0.5m of seabed.

1.4 Tow Forces and Plough Wear

The tow force and plough wear were incorporated in the five trenchability classes outlined in Table 1 above. Table 2 and Table 3 below assume a Standard SMD 1.1 share plough and provide separate classifications for tow forces and plough wear.

Table 2: Tow Force Classifications

Classification	Description
Low	Less than 15 tons
Medium	15 to 25 tons
High	May exceed 30T, with high variability and possible renders

The primary elements responsible for wear to the plough will be related to the perceived abrasiveness of the sediments, given that there is no direct measurement of abrasiveness.

Table 3: Plough Wear Classifications

Classification	Description
Low	Very soft to stiff silty CLAY, or clayey SILT
Medium	Very stiff silty CLAY, or clayey SILT, or very loose to loose silty SAND
High	Medium dense to very dense silty SAND

1.5 Required and Potential Burial Depth

The target burial depth and cable type was provided by ASN. The potential burial depth i.e. the maximum achievable burial depth using the Standard SMD 1.1 share plough, is provided in the BAS Summary below as well as graphically on the alignment charts. This assessment took into account the following parameters.

Seabed material strength – based on CPT and sampling results.

Anchors – based on survey observed vessel activity.

Fishing – based on survey observed fishing activity.

Water depth / seabed slopes – based on survey results.

Seabed Geology (slumps, mobile sands) based on survey results.

1.6 Tow Speed

Nominally plough installation speeds vary between 0.2 and 0.5 metres per second. Initial indications of tow speed are based on archival information. These initial indicative values take in to consideration the following:

Assumptions of a standard installation vessel, such as vessel power and the ability for the vessel to maintain a constant speed whilst ploughing, whether plough tow force are fed back into the DP (a more responsive, controllable operation can be achieved if this facility is available).

1.7 Seabed topography

Variability of sediment types (how frequently sediment types change).

Variability of depth of burial (how frequently are burial depths changing).

Water depth, e.g. with a large catenary set in deep water, a vessel may move along at a constant speed however the ploughs rate of advance and recorded tension will fluctuate as the belly in the tow wire is constantly changing.

1.8 Plough Risk Assessment

The risk assessment refers to the safety of the plough during the cable lay operation. The risk assessment matrix is based on a simplified points system outlined in Table 4**,** Table 5 and Table 6; the risk at any particular location is defined as the sum of the scores from each of the three tables. Note that if any

one of the criteria from a higher group within a table are present then the score from the higher group is applied:

A score of 0 -3 = No identifiable risk to the burial equipment

A score of 3 - 6 = Moderate risk to the burial equipment

A score of greater than 6 = High risk to the burial equipment

Table 4: Soil Strength Risk Assessment

Score	Risk Assessment Description – Soil Strength
1	Soil strengths in the range Cu 10kPa to 75kPa – Dr 10% to 65%.
2	Soil strength in the range Cu 75kPa to 150kPa – Dr 65% to 85%
5	Cu Less than 10kPa and greater than 150kPa – Dr less than 10% and greater than 85%

Table 5: Topography/Oceanography Risk Assessment

Score	Risk Assessment Description – Topography / Oceanography
1	Seabed generally flat, no sandwaves or pockmarks, seabed currents less than 1m/second, water depth less than 300m.
2	Sandwaves or pockmarks present but slope generally less than 10 degrees and depth of pockmarks less than 1m, seabed currents in excess of 1m/second, but less than 2m/second, water depths deeper than 300m but less than 700m.
5	Sandwaves or pockmarks present but slope generally greater than 10 degrees and depth of pockmarks greater than 1m, seabed currents greater than 2m/second, water depths deeper than 700m.

Table 6: Non-Geological Risk Assessment

Score	Risk Assessment Description – Non Geological
1	Minimal fishing activity indicated by low recorded sightings and /or minimal occurrence of seabed trawl scars, or fishing activity thought not to pose a significant risk to the plough. No anchorage within 1000m, low number of sonar contacts, no dredging activity, no significant marine traffic
2	Moderate fishing and other vessel activity which is thought to pose a moderate threat to the plough, sighting of working dredgers, no anchorage within 500m, moderate number of sonar contacts.
3	Significant fishing and other vessel activity which is though to pose a significant threat to the plough, anchorage within 500m, high number of sonar contacts

1.9 Presentation of Results

A table detailing the main BAS conclusions, by geographical and KP location is presented below.

Key BAS information has been represented longitudinally on the alignment charts for easy reference.

1.10 BAS Results

A burial assessment was undertaken from the start of planned burial on the California continental slope at KP4,031.756 to the seaward end of the bored conduit at the San Luis Obispo landfall, KP 4,125.961. The results of the BAS are summarised in Table 7 below.

Table 7: BAS Results Summary

Abbreviations: WD: Water Depth, D: Distance, ST: Sediment Type, TA: Trenchability Assessment, TBD: Target Burial Depth, PBDI: Predicted Burial Depth Indicator, BM: Burial Method (pl: plough, I: Injector, j: jetting PLB), TT: Tow Tension, WR: Wear Rate, PS: Plough Speed, CT: Cable Type, PRA: Plough Risk Assessment

POSITIONING							GEOPHYSICAL INFORMATION			ASSESSMENT										
Start Position			End Position			D	WD (m)	General Comments	ST (I, II, III, IV, V, VI)	TA (A,B, C,D,E)	TBD (m)	PBDI (m)	BM	TT (T)	WR	PS (km/ hr)	CT	PRA	Comments
KP (Km)	Latitude (N)	Longitude (E)	KP (Km)	Latitude (N)	Longitude (E)	km													
KP values based on RPL Version Number: AAG-Seg5_RPL_PSR04_22-Jan-08																			
Californian Continental Shelf																			
4031.756	35° 17.048'N	121° 53.025'W	4034.720	35° 17.46'N	121° 51.14'W	2.964	1850 to 1715	Start of SBP data coverage on California shelf. Thick sequence of very soft CLAY with slumping features	I	A	1.0	1.0	j				SA		No evidence of fishing activity. Slumping features indicate seabed instability.
4034.720	35° 17.46'N	121° 51.14'W	4038.760	35° 18.01'N	121° 48.56'W	4.040	1715 to 1538	Thick sequence of very soft CLAY	I	A	1.0	1.0	j				SA		No evidence of fishing activity.
4038.760	35° 18.01'N	121° 48.56'W	4044.499	35° 18.998'N	121° 44.973'W	5.739	1538 to 1278	Scattered ROCK outcrops where more resistant strata project to the seabed. Soft/loose sediment between outcrops	I - VI	D	1.0	0.0	j				SA		No evidence of fishing activity.
4044.499	35° 18.998'N	121° 44.973'W	4046.400	35° 19.360'N	121° 43.800'W	1.901	1278 to 1192	Moderately dense fine to medium SAND	III	B	1.0	1.0	pl	Med	High	1.0	SA	7	No evidence of fishing activity.
4046.400	35° 19.360'N	121° 43.800'W	4050.628	35° 19.235'N	121° 41.033'W	4.228	1192 to 1035	Moderately dense fine to medium SAND. Weathered ROCK approaches to within 1m of the seabed in places.	III - VI	B - C	1.0	0.5	pl	Med	High	0.7	SA	8	No evidence of fishing activity. ROCK outcrops within 50m of route in places.

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KP values based on RPL Version Number: AAG-Seg5_RPL_PSR04_22-Jan-08																			
Californian Continental Shelf																			
4050.628	35° 19.235'N	121° 41.033'W	4051.280	35° 19.165'N	121° 40.610'W	0.652	1035 to 1003	Weathered ROCK with patchy coarse sediment veneer	VI	C	1.0	0.5	pl	High	High	0.5	SA	11	No evidence of fishing activity. Plough "with caution".
4051.280	35° 19.165'N	121° 40.610'W	4052.940	35° 19.220'N	121° 39.520'W	1.660	1003 to 972	Moderately dense fine to medium SAND. Weathered ROCK approaches to within 1m of the seabed in places.	III - VI	B - C	1.0	0.5	pl	Med	High	0.7	SA	8	No evidence of fishing activity. ROCK outcrops within 50m of route in places.
4052.940	35° 19.220'N	121° 39.520'W	4054.100	35° 19.240'N	121° 38.760'W	1.160	972 to 952	Moderately dense fine to medium SAND	III	B	1.0	1.0	pl	Med	High	1.0	SA	7	No evidence of fishing activity.
4054.100	35° 19.240'N	121° 38.760'W	4054.520	35° 19.200'N	121° 38.480'W	0.420	952 to 948	Weathered ROCK with patchy coarse sediment veneer	III - VI	C	1.0	0.3	pl	High	High	0.5	SA	11	No evidence of fishing activity. Plough "with caution".
4054.520	35° 19.200'N	121° 38.480'W	4056.060	35° 19.110'N	121° 37.480'W	1.540	948 to 936	Loose fine SAND	II	A	1.0	1.0	pl	Med	Med	1.0	SA	7	No evidence of fishing activity. ROCK outcrops within 50m of route in places.
4056.060	35° 19.110'N	121° 37.480'W	4066.080	35° 19.190'N	121° 30.870'W	10.020	936 to 866	Sandy very soft SILT/CLAY. Some widely-spaced pockmarks	I	A	1.0	1.0	pl	Low	Low	1.5	SA	8	Trawl scars on seabed.
4066.080	35° 19.190'N	121° 30.870'W	4068.320	35° 19.190'N	121° 29.390'W	2.240	866 to 840	Mostly 1-2m of SAND over weathered ROCK	II	A	1.0	1.0	pl	Med	Med	1.0	SA	8	Trawl scars on seabed. Weathered ROCK may approach to <1m below the seabed in places.

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Californian Continental Shelf																			
4068.320	35° 19.190'N	121° 29.390'W	4069.600	35° 19.100'N	121° 28.555'W	1.280	837 to 843	Veneer to 2m of SAND over weathered ROCK	II - VI	C	1.0	0.5	pl	Med	High	0.7	SA	12	Trawl scars on the seabed. Possible cable within 100m. Variable thickness of sediment over ROCK. Steep slopes
4069.600	35° 19.100'N	121° 28.555'W	4070.530	35° 19.040'N	121° 27.960'W	0.930	843 to 896	ROCK ~1m relief, with patchy SAND veneer	VI	D	0.0	0.0	pl	High	High	0.5	SA	12	Trawl scars on the seabed. Route crosses possible existing cable. Steep slopes. Plough "with caution".
4070.530	35° 19.040'N	121° 27.960'W	4070.730	35° 19.020'N	121° 27.820'W	0.200	896 to 910	Veneer to 1m of SAND over weathered ROCK and ROCK	II - VI	C	1.0	0.5	pl	Med	High	0.7	SA	12	Trawl scars on the seabed. Possible cable within 100m. <1m thickness of sediment over ROCK
4070.730	35° 19.020'N	121° 27.820'W	4070.970	35° 19.010'N	121° 27.660'W	0.240	910 to 916	1m to 5m of SAND over ROCK	II	A	1.0	1.0	pl	Med	Med	1.0	SA	8	ROCK outcrops within 100m of route.
4070.970	35° 19.010'N	121° 27.660'W	4072.640	35° 19.120'N	121° 26.570'W	1.670	915 to 850	>5m of very soft to soft SILT/CLAY	I	A	1.0	1.0	pl	Low	Low	1.5	SA	7	No evidence of fishing activity.
4072.640	35° 19.120'N	121° 26.570'W	4073.080	35° 19.150'N	121° 26.280'W	0.440	850 to 843	>5m of very soft to soft SILT/CLAY. Widely spaced pockmarks up to 20m diameter.	I	A	1.0	1.0	pl	Low	Low	1.0	SA	7	No evidence of fishing activity. Widely spaced pockmarks.
4073.080	35° 19.150'N	121° 26.280'W	4092.570	35° 19.570'N	121° 13.450'W	19.490	843 to 490	>5m of very soft silty CLAY. Mostly featureless seabed	I	A	1.0	1.0	pl	Low	Low	1.5	SA	7	A few trawl scars

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4092.570	35° 19.570'N	121° 13.450'W	4102.680	35° 19.660'N	121° 06.780'W	10.110	490 to 326	>5m of very soft clayey SILT. Widely spaced pockmarks up to 25m diameter.	I	A	1.0	1.0	pl	Low	Low	1.0	SA	4	No evidence of fishing activity. Widely spaced pockmarks.
4102.680	35° 19.660'N	121° 06.780'W	4118.084	35° 19.778'N	120° 56.691'W	15.404	326 to 79	>3m of very soft clayey SILT. Irregular depressions in seabed (biological)	I	A	1.0	1.0	pl	Low	Low	1.5	SA / DA	4	Sightings of a few fishing vessels. IS CX at KP4111.366 & KP4115.156. ROCK outcrops within 50m of route around KP4117.9.
4118.084	35° 19.778'N	120° 56.691'W	4119.210	35° 19.800'N	120° 55.975'W	1.126	79 to 73	>1m of very soft to soft clayey SILT and loose silty SAND.	I - II	A	1.0	1.0	j				DA		ROCK outcrops within 50m of route around KP4119.1
4119.210	35° 19.800'N	120° 55.975'W	4119.260	35° 19.805'N	120° 55.940'W	0.050	73 to 72	ROCK outcrop	VI	D	1.0	0.0	j				DA		
4119.260	35° 19.805'N	120° 55.940'W	4123.230	35° 19.480'N	120° 53.385'W	3.970	72 to 30	Loose to moderately dense silty SAND. Weathered ROCK <1.0m below seabed in isolated patches	II - III	B	1.0	1.0	j				DA		Minor irregular bedforms and sand ripples up to 0.1m amplitude. IS CX at KP4122..865 & KP4123.057. ROCK outcrops within 50m of route around KP4119.5.

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4123.230	35° 19.480'N	120° 53.385'W	4123.810	35° 19.230'N	120° 53.270'W	0.580	30 to 26	Soft to firm sandy SILT and moderately dense silty SAND. Patches of weathered ROCK <1.0m below seabed	II - III	B	1.0	1.0	j				DA		Route veers around ROCK area, with outcrop within 50m of route. No CX, but IS cables within 50m.
4123.810	35° 19.220'N	120° 53.270'W	4125.961	35° 18.250'N	120° 53.109'W	2.151	26 to 13	Soft to firm sandy SILT	II	B	1.0	1.0	j				DA		IS CX at KP4124.833, KP4125.005 & KP4125.079. OoS CX at KP 4125.149. ROCK outcrops within 50m of route around KP4125.3.